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Lubrication

A Technical Publication Devoted to the Selection and Use of Lubricants

THIS ISSUE

Lubrication
in
Forging Operations

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LUBRICATION

A TECHNICAL PUBLICATION DEVOTED TO THE SELECTION AND USE OF LUBRICANTS

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Lubrication in Forging Operations

FROM the very beginning of mechanized forging, the problem of lubrication has been serious enough to require considerable study. Heat, pressure, water and lubricant-contamination are the contributing factors. These conditions have had a lot to do with the development of the various lubricating systems in use today. As mass production requirements increased and rapidity, as well as accuracy, of forging parts for automotive engines, for example, became primary objectives, lubrication of press and hammer mechanisms was given more attention. These machines were part of a production line, even though very often they might be located in another county or state. If they failed and required repair or replacement of scored bearings, flow of semi-finished materials to the machine tool shop and finishing line could easily be disrupted.

This caused the lubricating engineer, the designer and the operator all to consider more dependable methods of lubrication. Then bearing design was reviewed in order to provide better protection against entry of non-lubricating matter.

TUBAL CAIN made biblical history when he discovered that it was possible to work "black stones" into useful shapes by the combined effects of heat and hammering. Down through the ages, man improved upon this art of working metals. As ways and means of developing pressure were unknown, however, he always had to resort to hammering. The results of his artistry are retained today as museum pieces throughout the Western World.

Forging, as this working of metals came to be known, continued to be a manual process of hammering until the use of steam became available and the steel industry had progressed sufficiently to produce the structural steel required for the steam hammer. Then drop forging came into being and it was possible to work with pieces of very much larger size than the blacksmith could handle. In reality, forging became a vital part of mechanized industry and engine development.

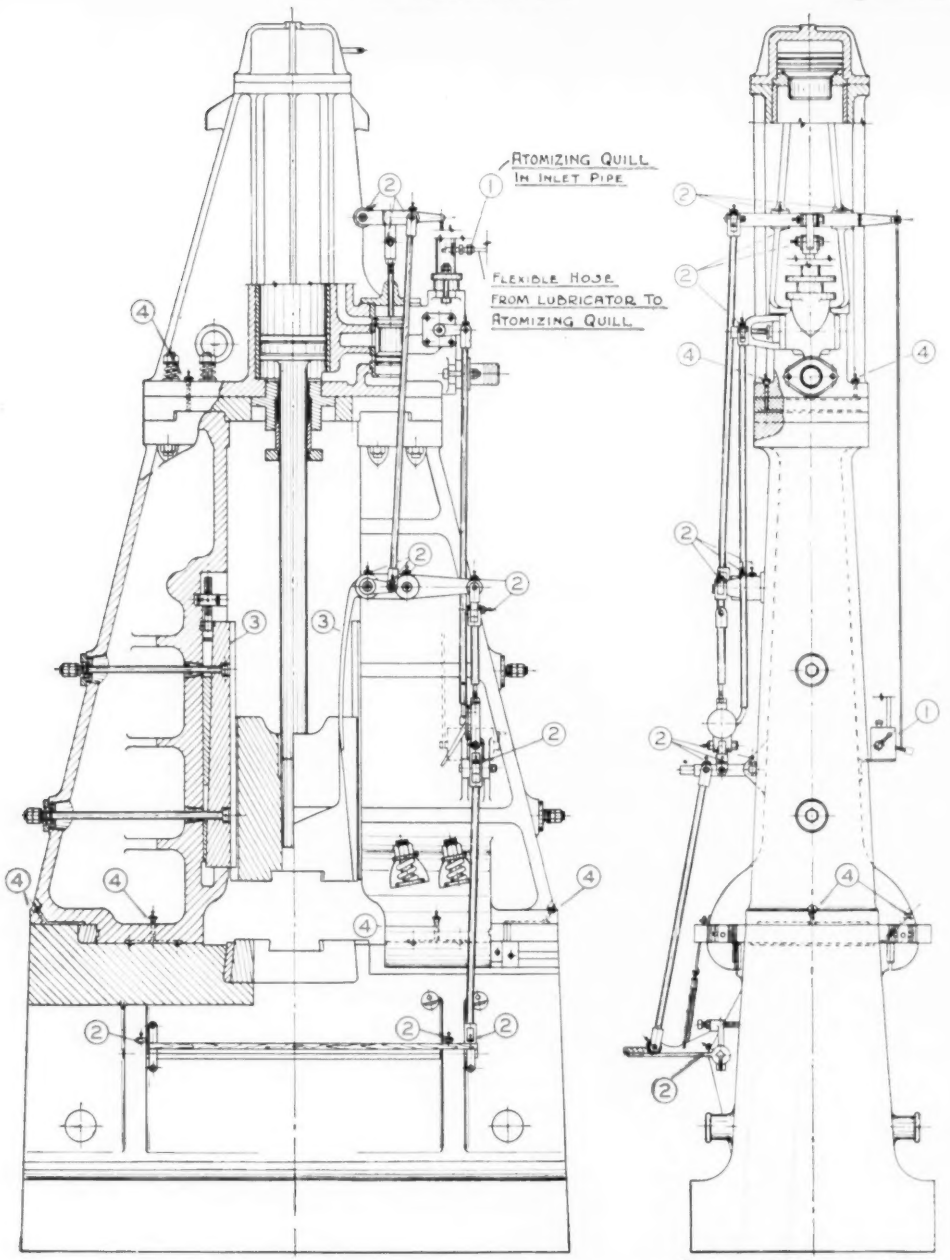
In forging, the metal is heated, prior to working. Steel for example, is heated to a bright red heat. In contrast with foundry practice, the metal is not melted but simply heated until it is soft enough to flow into the desired shape by the impact of the forging hammer or the pressure of the forging press.

The Reason for Heat

Heat is present around a forging hammer or press, due to the temperature of the metal passing through it. Pieces ranging up to several tons in weight, pre-heated to a bright red (in the case of steel), carry a lot of heat through the machine. It is dissipated by radiation as the pieces are worked and cooled. A considerable amount of this heat is transmitted to the working parts, the control valve mechanisms, the bearings, the gears, and the guides.

Heat tends to make any lubricant more fluid. This must be considered when selecting the products for any such mechanisms. It means that somewhat heavier or more viscous lubricants are required than for ordinary temperature service.

Controlled lubrication by measuring equipment will prevent this possibility to a large degree. Use of a centralized pressure lubricating system, on a press for example, will insure that just so much grease or oil is de-



Courtesy of Erie Foundry Company

Figure 1 — Lubrication diagram for an Erie Steam Drop Hammer. (1) indicates the mechanical force-feed cylinder lubricator and the atomizing quill in the inlet pipe. (2) indicates the various points of the valve gear which must be lubricated — generally with the same oil as used for the cylinder. (3) shows the ram and ram guides. (4) the several flat or horizontal bearing surfaces, lubricated by pressure gun.

livered to a bearing each time the lubricator functions.

The same principle applies to the mechanical force feed oiler which is today so widely preferred for lubricating the steam cylinder and valve on a steam hammer, or the valve mechanism on an air pressure machine.

Pressure Is Reaction Type

Pressure on the moving parts of an impact forging hammer is reactive. In other words, there are no abnormal pressures exerted while the piston rod or ram is being raised, but as it falls or is impelled downward to strike the piece on the anvil, the pressure exerted reacts upward and back upon the

guides and upon the cylinder, stuffing box and valve mechanisms.

On a forging press, the pressure is also reactive, but of a more continuous nature while the piece is being formed. In other words, there is less shock on the entire machine than in a hammer. This holds true whether the forging press is motor driven or controlled by hydraulic power.

Impact or reactive pressures exert a squeezing out action upon the lubricating film in a bearing clearance space or on gear teeth. It can be more serious on the latter, as the lubricating film is not confined and can spread out too thinly to give ample tooth protection on the next contact unless the film is renewed. This is approaching boundary lubrication and is one of the reasons for the perfection of Extreme Pressure lubricants which are now so widely preferred for heavy duty gear service.

Water from Condensed Steam

Water can affect stuffing box and guide lubrication in a steam hammer. It results from leakage of condensed steam which drips or throws onto the guides. Leakage along the piston rod or ram obviously can affect the durability of the lubricant in the packing.

The detrimental affects of water are obviated by using lubricating oils of suitable emulsifying characteristics. These are obtained by compounding straight mineral oils with a small amount of fixed or fatty oil which will cause the lubricating film to develop an emulsion or lather when water comes in contact with it. Such emulsions are more cohesive and adhesive to metallic surfaces than straight mineral oils. (See steam cylinder lubrication discussion.)

The Parts to Be Lubricated

In addition to knowledge of the operating conditions, the type of motive power applied to forging machines must be studied. Basically it will involve, steam, air, steam and water (hydraulic), oil (hydraulic), or electric motor driving through reduction gears or V-belts.

The drop hammer is driven by steam or air power; the board drop hammer by line shaft or motor drive. Drop hammers are used for drop forging heavy pieces at very high pressures where flat bed forming is very often employed, the faces of the ram and anvil serving as the dies.

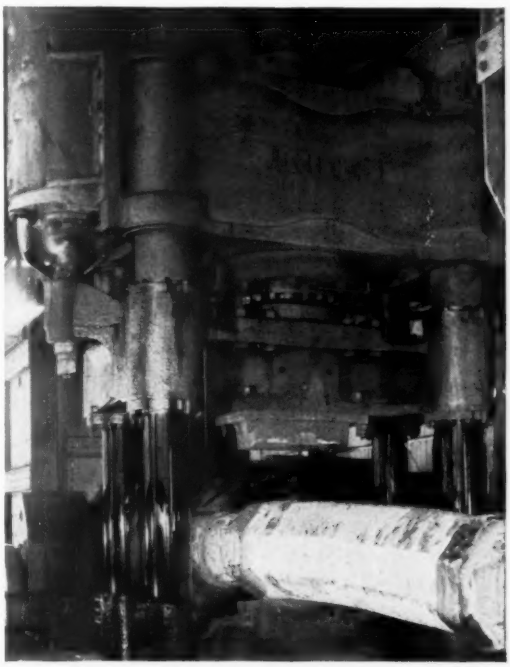
Forging presses involve hydraulic operation or motor drive through reduction gear and cam arrangements, or a crankshaft and driving gear. Forging machines are more generally applicable to upsetting work in the production of smaller parts.

POWER DRIVES

Steam

Steam — a source of energy used for centuries, and, at present, in almost every industry — is widely used as the motivating power in forging machinery. A glance at the various types of forging machinery illustrated on pages 102 and 103, for example give some indication of the various kinds operating on steam.

On forging equipment motion is obtained from steam pressure acting on a piston contained in a suitable cylinder. It is absolutely essential that the



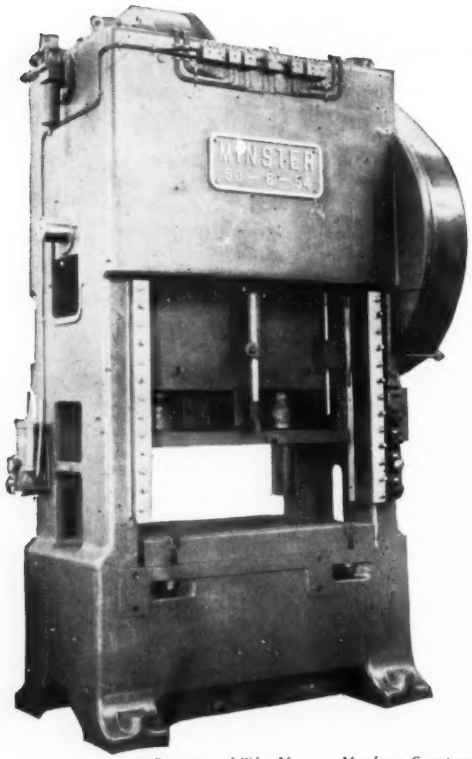
Courtesy of United Engineering and Foundry Company

Figure 2 — A United, 1,500 ton forging press showing the location of the guides with respect to the piece being forged. Obviously radiated heat must be carefully considered in choosing the lubricant for these guides.

cylinder walls be lubricated, and the easiest way of getting the lubricating oil to all desired points is to make use of the steam itself. This is accomplished by injecting the oil into the steam line at a point prior to the steam's entry to valves and cylinders.

If the oil is divided into minute globules as it enters the steam line and is then mixed intimately with the steam, all moving parts will be adequately lubricated.

The more complete the atomization and the more thoroughly the oil is dispersed through the steam, the better will be the lubrication of valves and cylinders and the more economical the consumption of



Courtesy of The Minster Machine Company

Figure 3 — Showing a Minster No. 50-6-54 press equipped with a Farval Dualine, manually-operated grease system.

oil. The degree of atomization of the oil is influenced by the condition of the steam, the point of introduction of the oil, the velocity of the steam and the character of the oil.

It is advisable in order to obtain good atomization that the point of entry of the oil into the steam line be located two to six feet before the valve or cylinder. If an oil is used which atomizes quickly, the point of entry can be close. On the other hand, more economical lubrication may be obtained, particularly with higher viscosity oils, if the point of entry is not too close.

The choice of a suitable lubricating oil depends upon many factors, such as:

1. Are conditions such that the oil will atomize easily? (This often depends upon the type of atomizer used.)
2. The steam pressure, and whether the steam is superheated, or contains some condensate.
3. Subsequent use of the steam. If it is to be used for heating or condensed and used for boiler feed, it is necessary that the oil be removed.

Generally the steam used in forging plants ranges in pressures from 80 to 150 pounds per square inch. Since the boilers are usually some distance from the forging machinery, normally some of the steam condenses in transit to form what is known as "wet steam," that is, it contains some condensate.

The presence of moisture in the steam will usually result in a film of straight mineral lubricating oil being readily washed off from the cylinder walls and other surfaces with which the steam comes in contact. Therefore, to secure the proper lubrication under wet steam conditions, it is necessary to either increase the rate of flow of straight mineral oil (which may not be economical) or use an oil containing a certain percentage of fatty compound such as lard oil, degras, or tallow.

Compounding develops an emulsion through mixing of the compounded oil with moisture in the steam. The lubricating film of emulsion thus formed has a great affinity for the wearing surfaces and is resistant to the washing action of the water. The greater the percentage of moisture in the steam, the higher should be the fatty compound content of the lubricant, though ten to twelve per cent is the usual maximum.

In many plants the steam after use in forging equipment is condensed and used as boiler feed, or used at low pressures for heating purposes. In either case, it is advisable to first separate the oil from the steam or condensate. Unfortunately, the property which causes compounded oils to unite with water to form emulsions in the cylinders also prevents ready separation from steam or condensate. Likewise, the more completely the oil is atomized the more difficult it is to separate from water.

To attain effective lubrication of steam cylinders, one must have a thorough understanding of the operating conditions. Too often the value of effective lubrication is lost sight of because of other pressing maintenance problems. If in doubt concerning the choice of a suitable steam cylinder oil, the services of a competent lubrication engineer should be enlisted. He has behind him years of research by petroleum chemists plus a wealth of application experience.

Air

Steam forging hammers are normally used for preliminary forging operations and for small quantity production on pieces of considerable size. Although these hammers are normally called steam hammers, they can be operated on either steam or compressed air. The choice depends on the availability of steam or air at the location of the machine.

There are also pneumatic hammers operating on air which are distinctive from the forging hammer. In these, power is supplied by an electric motor which drives a double-acting compressor cylinder interconnected with a double-acting power cylin-

der, air being used as the medium for moving the power cylinder.

Air Cylinder Lubrication

Air cylinder lubrication is important in that the oil must be resistant to formation of objectionable carbon deposits and gummy residual matter.

When air is compressed, heat is developed. As a result, the oil film on the discharge valves can be exposed to a sufficient amount of heat (according to the pressure) to cause partial distillation. As this continues, the lighter hydrocarbon portions which evaporate from some oils are carried off with the discharged air, leaving the heavier (and perhaps gummy) fractions in the cylinder where they tend to build up sticky, oily deposits. A well refined compressor oil resists decomposition tendency so that a cleaner compressor system will result.

Dust and dirt from the surrounding atmosphere will be carried into the forge compressor unless the air inlet is equipped with a filter. As forge shop air is naturally dusty, a filter is decidedly beneficial as it insures against abrasive dust getting into the compressor cylinder to mix with oily residues and cause stuck piston rings and cylinder wear.

For air cylinder lubrication a straight mineral oil, specially refined for compressor service of around 300 seconds Saybolt Universal Viscosity at 100° Fahr. is usually recommended. Not much oil is required for air cylinder lubrication—only a few drops a minute — the rate of delivery being accurately controlled by a mechanical force feed oiler.

Hydraulic Power

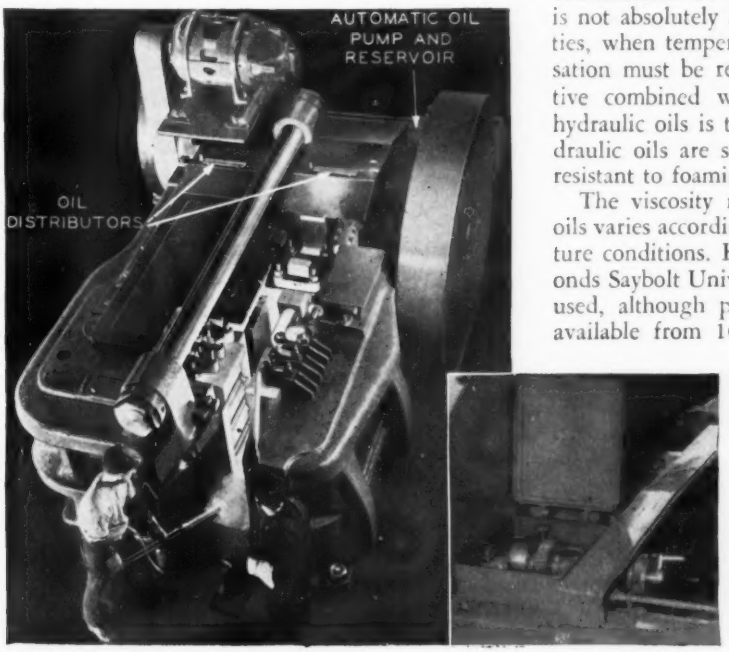
Most parts on a hydraulic forging press are lubricated by the hydraulic oil which is used to operate the machine. It is an automatic procedure in which the oil lubricates as it is circulated. Normally the only external lubrication required is on the surfaces of the press slides or uprights. This is done by means of an external oil circulating system which delivers a measured quantity of oil at each stroke of the press.

Only the highest quality oil should be used for hydraulic forging press operation. It must be resistant to oxidation and capable of protecting the surfaces of the hydraulic pumping system against rust. Oxidation of hydraulic oils is a factor which may cause considerable trouble if a suitable oil is not used.

There would appear to be but remote possibility of rusting as such systems generally are water-free at the start and the moisture content of petroleum oils is negligible. There is, however, possibility of condensation of moisture from air, as the system is not absolutely air-tight. In damp, humid localities, when temperatures may vary widely, condensation must be reckoned with. An anti-rust additive combined with oxidation inhibitors in the hydraulic oils is the answer. In addition some hydraulic oils are so processed that they are highly resistant to foaming — a very desirable property.

The viscosity range of forging press hydraulic oils varies according to the size, speed and temperature conditions. Hydraulic oils of 300 to 500 seconds Saybolt Universal at 100° Fahr. are generally used, although products of the same quality are available from 100 to very nearly 1000 seconds viscosity to meet the requirements of specific builders of hydraulic systems.

The lubricating ability of these oils is equally as dependable. By their resistance to oxidation and their high degree of lubricating value, they insure that lubrication of the working mechanisms of the system will be maintained free from gum-forming deposits and capable of immediate reaction to the control system.

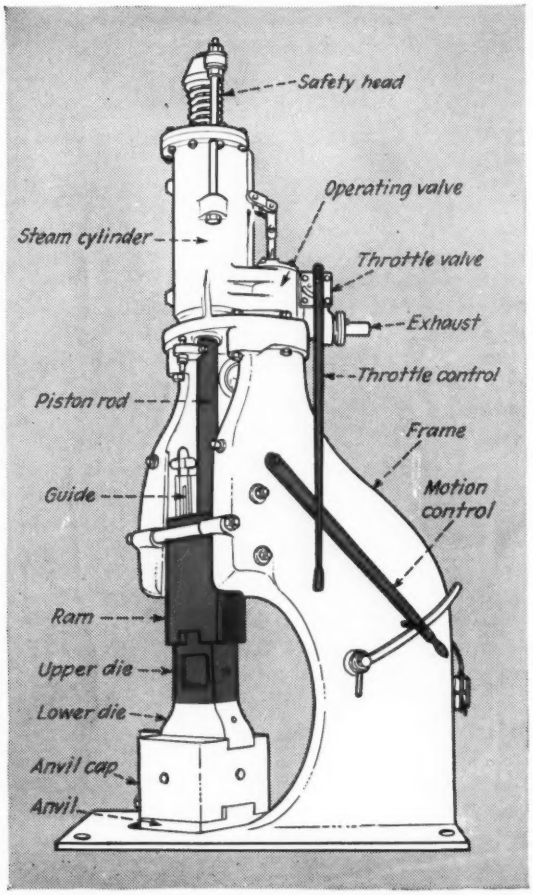


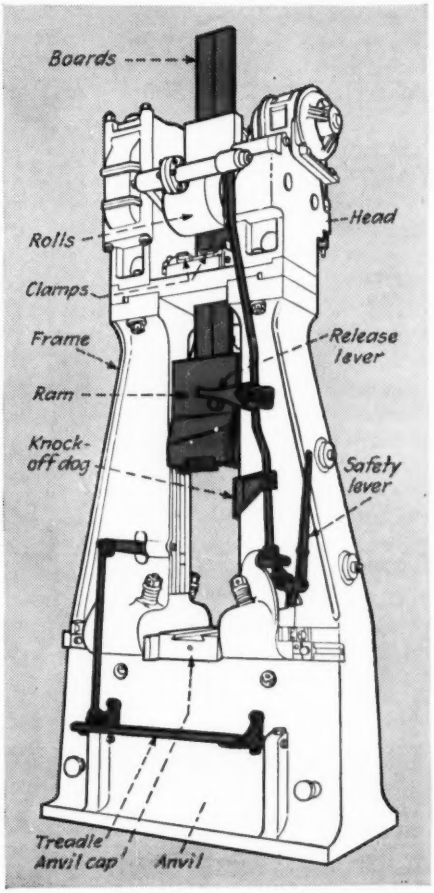
Courtesy of The Ajax Manufacturing Co.

Figure 4 — (Left) An Ajax Air Clutch Forging Machine showing locations of the automatic oil pump and reservoir and the oil distributors. (Right) A double plunger pump submerged in the oil reservoir and driven off the crankshaft by a ratchet arm delivers oil to the oil distributors or headers from which it is piped to the oil pocket of each bearing. The lubricating system piping is under cover to protect it from damage.

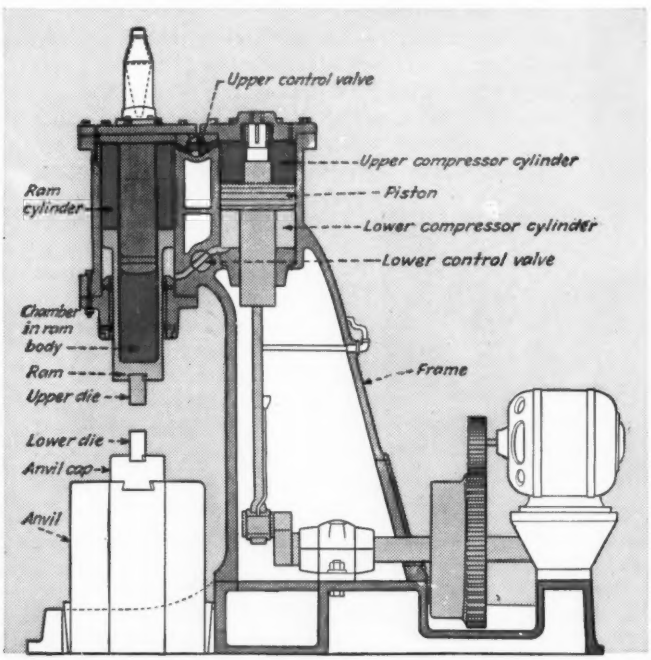
ELECTRIC MOTOR BEARINGS

Motor bearings on forging machinery or forging presses





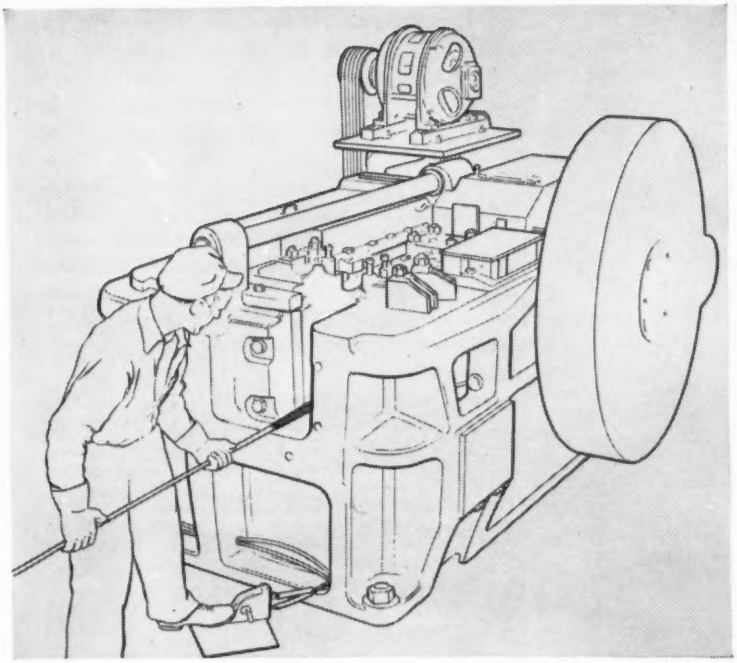
Courtesy of "American Machinist"



(Top left) A single frame steam forging hammer with separate anvil.

(Top right) A board drop hammer. Motor drives through direct gearing to a pair of lifting rolls. Large hammers use two pairs of lifting rolls.

(Bottom left) Showing a pneumatic motor-driven hammer powered by individual motor through reduction gearing.

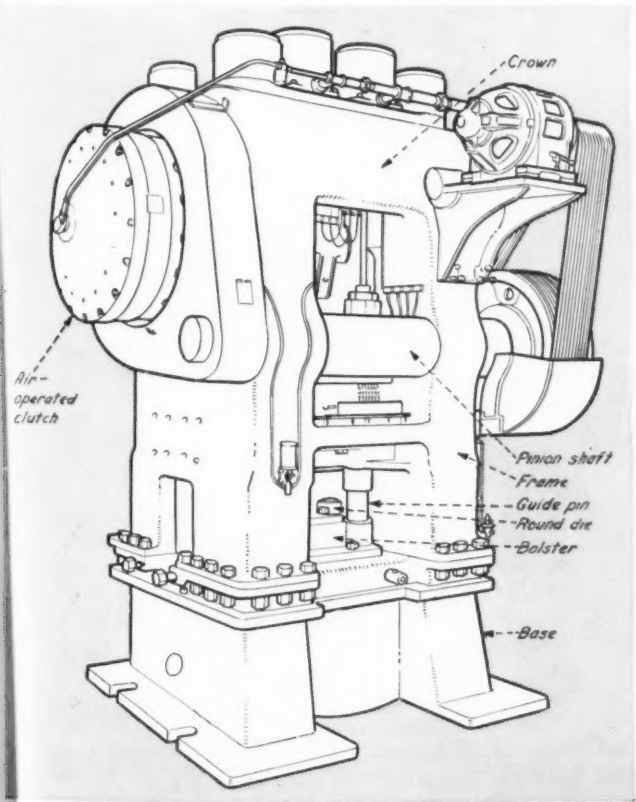


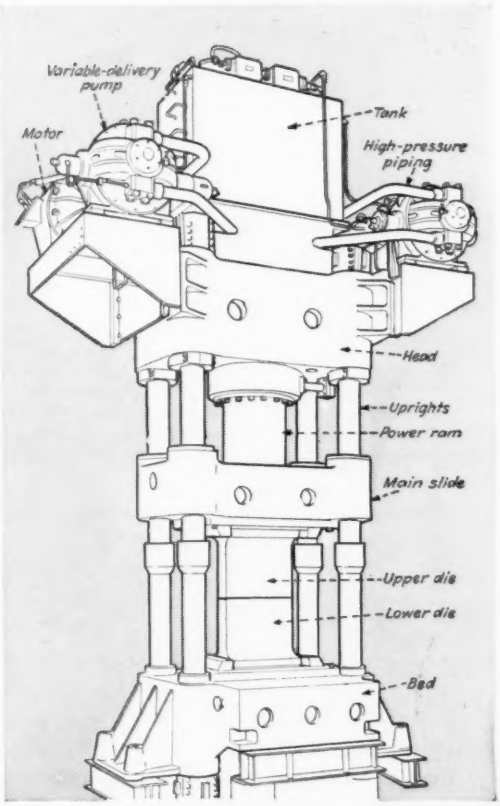
Courtesy of "American Machinist"

(Top left) An upset forging machine showing how heated bar stock is handled. Note motor and V-belt drive.

(Bottom left) A large air-clutch mechanical forging press showing feature parts.

(Bottom right) A 1,000 ton hydraulic press equipped for flat die forging. Hydraulic pressure is provided by two piston-type generators each driven by an electric motor.





are lubricated according to the design of the bearings, i.e. Sleeve type bearings which are ring-oiled, or anti-friction bearings which are pressure grease lubricated.

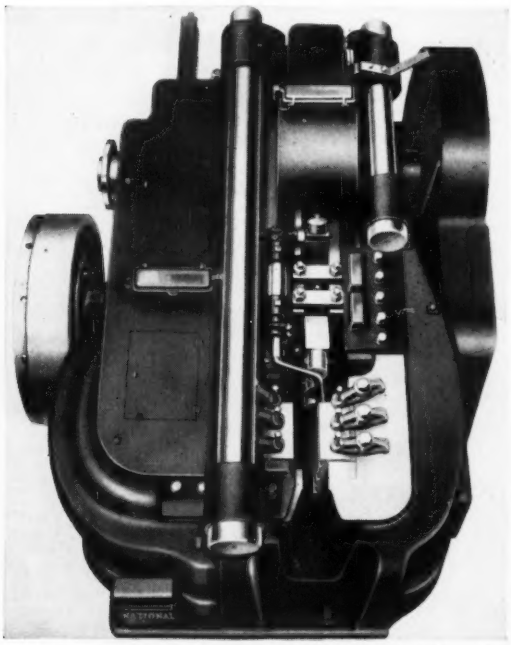
Ring Oiled Bearings

In planning for the lubrication of ring-oiled sleeve bearings a limited quantity of oil is involved which is subjected to very rapid circulation by the turning of the ring which is suspended from the rotor shaft. When this ring turns, it dips in the oil in the bearing reservoir, and a certain amount of oil is continually carried up to the surface of the shaft and into the bearing clearance. This is oil circulation in its simplest form.

Ring oiled motor bearings often run comparatively warm due to limited provision for cooling. This is very apt to happen if the oil level is carried too high. If the level is right, so that the ring just dips, the oil reservoir in the average ring-oiled bearing will contain sufficient oil so that time will be permitted for a certain amount of rest, and settling out of contaminating foreign matter which might have been picked up through windage. Well refined, light bodied oils (from 200 to 300 seconds Saybolt Universal Viscosity at 100° F.) such as are used in average forge shop motors, settle out contaminants very readily.

Ball and Roller Bearings

The duty of the lubricant in a ball or roller bearing motor is interesting. It extends beyond lubrication. The ability to prevent actual metallic friction must be augmented by the protective ability, whereby the lubricating film is such that corrosion is prevented regardless of the atmospheric conditions. It was this requirement which prompted so much active research on the part of the petroleum industry. As a result of this research there has been remarkable progress in the development of materials to retard oxidation and corrosion, and in the formulation of refinery procedures which render ball and roller bearing lubricants usable over a wider range of temperatures than ever before. These products retain their intended physical and chemical state and withstand the gum-forming effects of oxidation, to a remarkable degree.



Courtesy of The National Machinery Co.

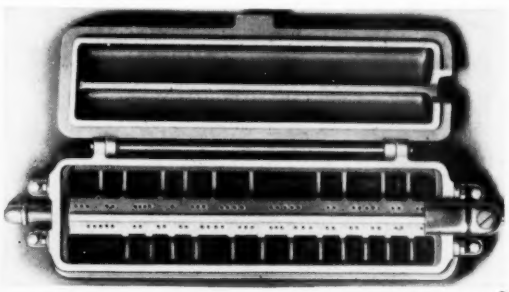


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Figure 5 — The automatic oiling system as applied to the National High Duty Forging Machine: (1) is a top view of the machine showing the covers which keep dirt, moisture and scale from the moving parts, (2) shows the arrangement for oil rationing according to the bearing requirements; oil emerging from two rows of holes to flow into pockets from which it runs to the bearings, (3) shows the reservoir in which two plunger type oil pumps are submerged, and driven automatically by the machine, (4) is the piping layout of the distributor system (under the cover) which can be removed as a unit.

POWER TRANSMISSIONS AND SPEED REDUCTION GEARS

Reduction gears are used in pneumatic motor-driven hammers, and mechanical forging presses. In the former, the gearing transmits the motor power at reduced speed to the piston in the air compressor cylinder; from here, air power actuates the ram in the power cylinder. In the forging press, gearing transmits motor power to a back shaft, flywheel and clutch to the main crankshaft.

Lubrication of gears in this service depends upon how they are installed. If an oil-tight housing is provided, bath lubrication with a comparatively fluid oil is practicable. Another advantage of a tight housing is that the gear teeth and lubricant are protected against dust, dirt, scale and moisture. This permits the usage of a higher quality gear lubricant.

The viscosity or body of the lubricant will depend upon the loads which must be carried by the gears. A comparatively thick lubricating film is often conducive to best protection of exposed gears though it should not be so adhesive as to develop abnormal drag; this would increase the power consumption, especially on starting or when operating under comparatively low temperature conditions.

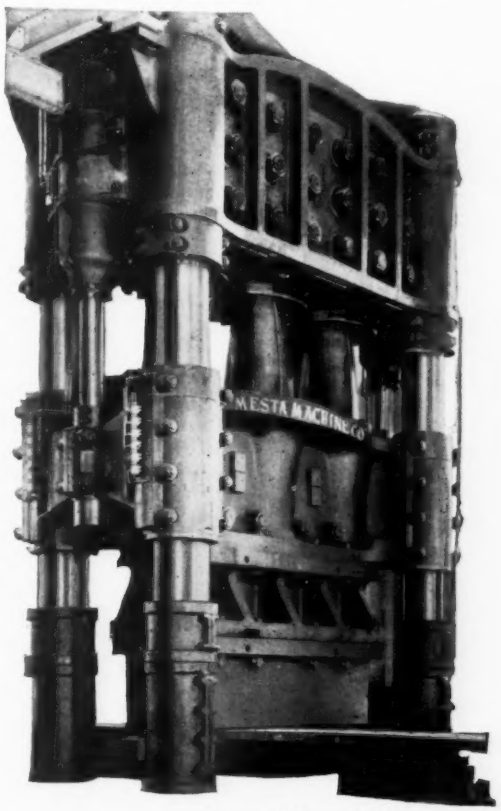
Excessive noise can usually be taken as indicating that gears are not lubricated as they should be. Temperature is also a factor though it is almost impossible to use the temperature of the gear case as a criterion, as is practicable where bearings are involved. With bearings abnormal metal-to-metal friction will frequently be indicated by an increase in temperature which can oftentimes be felt by hand. In a gear case, however, there is so much more space available that any heat which might be developed through actual metallic contact between gear teeth would probably be dissipated before it has a chance to raise the temperature of the case.

Whenever wear may be suspected, or noise may indicate faulty lubrication, it is well to clean the gears with a comparatively light machine oil or flushing oil. Then the extent to which wear has been occurring can be observed. If this has not gone too far, it is necessary only to re-lubricate and proceed with the operation. Generally speaking, however, even though there is no indication of excessive noise, cleaning out gear cases about twice a year will be advisable where a machine has been in operation comparatively steadily. This holds true especially if metallic contaminants have had a chance to work in and reduce the lubricating ability of the gear lubricant.

Exposed Conditions

Where gears are exposed, or not fully enclosed the problem of protecting the wearing surfaces of the teeth is more difficult than with fully enclosed gears. The essential factor is to select a lubricant which will adhere tenaciously to the teeth and resist the throwing-off effects of centrifugal force.

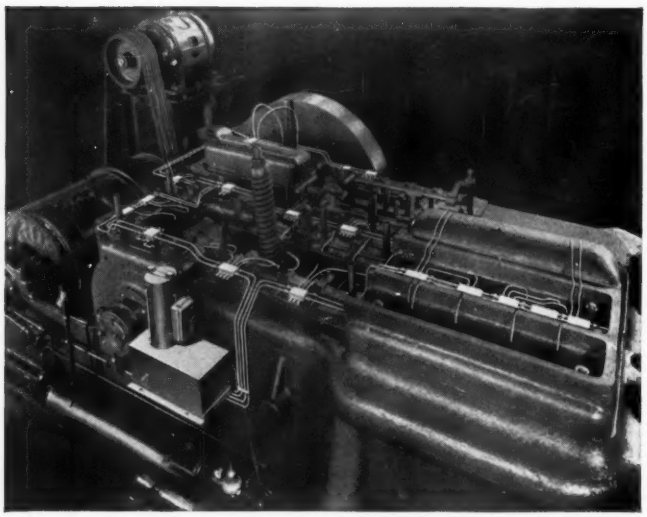
Where the extent of contamination may be high, cleaning and re-lubrication should be done more frequently as heavier gear lubricants which retain contaminants can develop into abrasive grinding compounds. It is for this reason that the more adhesive types of strictly gear lubricants are not always as satisfactory for such gears, as are those more fluid products which will keep the gear teeth free from accumulation of abrasives by virtue of their washing action.



Courtesy of Mesta Machine Company

Figure 6 — A Mesta 14,000 ton hydraulic forging and bending press showing some of the features of the lubricating system.

This latter action, however, will involve the necessity of suitable drip pans in order to prevent a sloppy and hazardous condition around the machine. It is difficult to practice oil economy where lubricant is used in this manner. On the other hand, oil economy, in forging, while important, must frequently give way to machine protection and the more outstanding essential of continuous production.



Courtesy of The Farval Corporation

Figure 7 — The Farval full automatic system of centralized lubrication on an Acme forging machine. This system provides regular and frequent delivery of lubricant to all bearings, slides, toggle links, and the large diameter heavily loaded main eccentric bearing on such machines.

Lately, there has been a decided trend towards the mild, non-corrosive type of Extreme Pressure oil for such service. The load and operating conditions favor this trend, and furthermore, lubricants of somewhat lower viscosity can be used. The load carrying capacity is obtained by blending high quality mineral oils with carefully selected lead soaps, in such a way as to produce compounds of marked stability and adhesiveness.

Other outstanding characteristics of this type of lubricant are:

1 — non-corrosive to steel used for gears or to copper, bronze, or cadmium-nickel bearing metals.
2 — exceptionally good adhesive qualities even when gears are deluged with water.
3 — does not separate in storage or service.
4 — retains its Extreme Pressure characteristics during lengthy service.
5 — can be mixed or thinned down with a lighter grade of the same type of oil if cold weather service or more easy application requires a product of lower viscosity.

AUTOMATIC OIL LUBRICATION

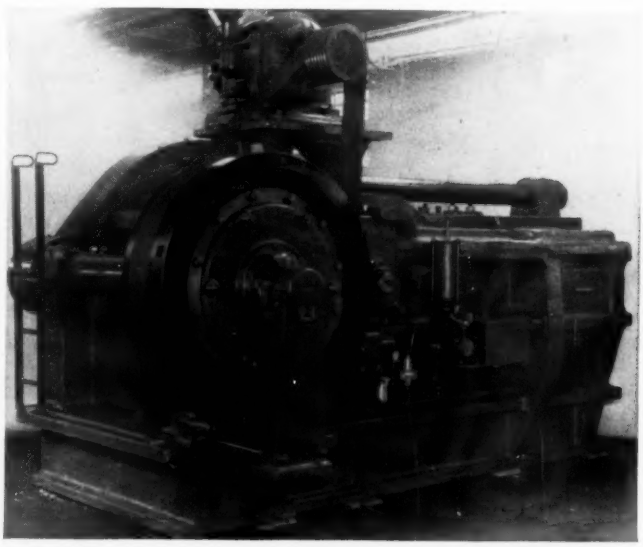
Handling of fluid oils under uniform pressure conditions is helpful in reducing operating temperatures through the cooling effect of the fresh oil. A variety of systems have been worked out ranging in simplicity from the unit type of force feed oiler to the multiple feed devices whereby an entire series of bearings can be served by measured quantities of oil under the same constant pressure. The principles as involved in the mechanical force feed oiler are applicable to delivery of

a) Steam cylinder oil to the cylinders of the steam hammer
b) Air compressor cylinder oil to the air cylinder of the pneumatic hammer and
c) Bearing lubrication of air clutch forging machines.

The Mechanical Force Feed Principle

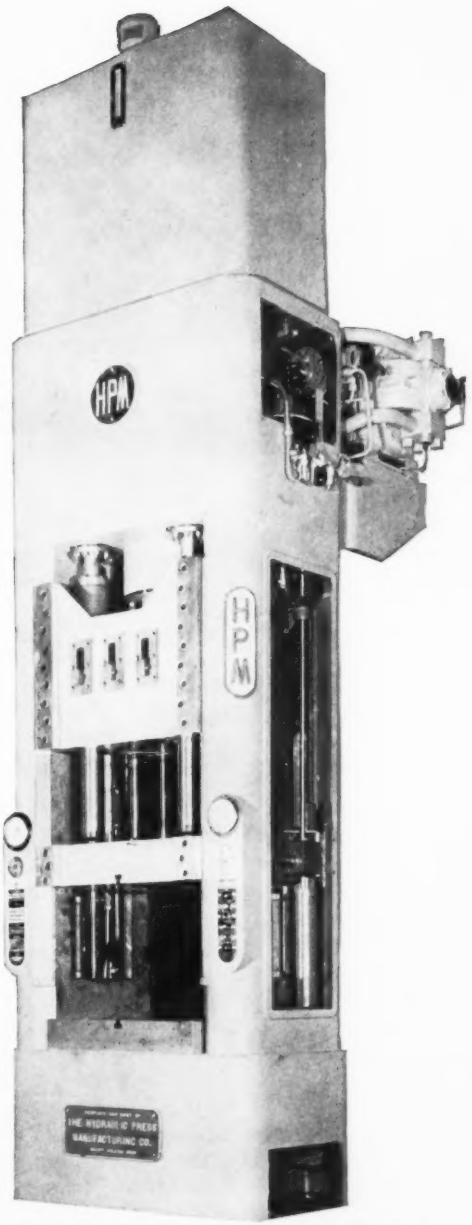
In a device of this type the lubricator is connected directly to some reciprocating part of the machine. As a result oil is fed to the various cylinder outlets or to the bearings at a rate which varies directly with the speed of operation. This type of lubrication functions only when the machine is running, hence there is little chance of wasting oil or flooding the parts to be lubricated.

Mechanical force feed lubrication has other advantages in that it normally will feed the same amount of oil regardless of the temperature, the



Courtesy of Trabon Engineering Corporation

Figure 8 — Showing application of a Trabon Type M, positive force feed lubricating system to an Ajax up-set forging machine. High bearing pressures, heat and vibration make automatic lubrication a very desirable procedure on such equipment.



Courtesy of The Hydraulic Press Manufacturing Company

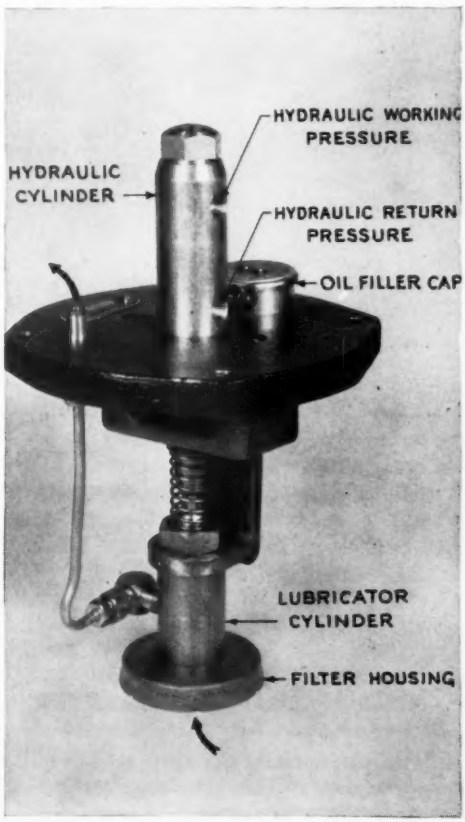
Figure 9 — The H-P-M 200-ton CU-3 Fastraverse hydraulic press. No lubrication is required except the ways on the uprights which are contacted by the gibs which are fastened on the slide. This lubrication is furnished by a Bijur system using oil from the surge or supply tank.

viscosity of the oil or the amount of oil in the reservoir. The quantity of oil delivered is regulated by adjusting the length of the plunger stroke or the time required to complete a stroke.

The Type of Oil

The nature of the oil is important. In addition to being a well refined product with good chemical stability, it must have good relative fluidity at low temperatures. As measured by the viscosity and pour test, the fluidity, especially at low temperatures, becomes highly important in conjunction with the pressure available. The pour test requires consideration, especially when the machines are subject to low temperature starting conditions because the rate at which the oil will flow may be affected in a system where the oil is recirculated. Should it become too sluggish at any time, flow off from a bearing might be impaired to cause backing up of the oil in the system. Furthermore, if any bearings are improperly sealed, oil might leak from the case. This would result in waste as well as a sloppy condition on the operating floor.

Where the viscosity or pour test are too high the decreased fluidity may also develop marked increase in power consumption. This would prevail throughout the system, for not only would the circulating or oil delivery pumps have to do extra work, but



Courtesy of Bijur Lubricating Corporation

Figure 10 — Pump unit details of the Bijur type "Y" lubricator. Hydraulically operated, this device force-feeds a measured quantity of hydraulic oil to a 5-way junction on the H-P-M Fastraverse press from which run four feed lines, one to each press guide.

also the main drives might feel the extra duty demanded due to the increase in internal friction within the lubricant itself. As the automatic nature of any such system is increased, more careful consideration of these factors of pour test and relative fluidity is required. The oil system piping must always be of ample size to prevent abnormal friction losses occurring within the system, or reduction in oil flow.

The Detriment of Water

Water has already been mentioned. It becomes a factor with respect to lubrication whenever it may come in contact with the lubricating film. This must be considered in the steam hammer, both with regard to cylinder lubrication, as well as leakage of condensate from the piston rod stuffing box. Water leakage can throw onto the guides which keep the ram in position, and cause wear if the lubricating film is not resistant to water. For this reason highly adhesive products generally are used for guide lubrication, and compounded steam cylinder oils for the cylinder.

In a pressure oiling system water is objectionable, for it may seriously impair the lubricating ability and cause sludge to form which may prevent free flow of the oil. For this reason, the oil must be comparatively water-free at the beginning, and able to separate readily from water. In such systems straight mineral oils are used.

The responsibility devolves upon the designing engineer to plan for a water-tight system and the operator to keep it so. Prevention of entry of water into a pressure oiling system adapted to an existing machine, however, may require some study as minor changes in construction may be necessary.

CENTRALIZED PRESSURE SYSTEMS

The application of centralized pressure lubrication systems capable of handling grease or heavy oil is another very prominent advancement in the lubrication of drop hammers and other types of forging machinery. The basic features are of interest, viz.

1. Positive delivery of measured quantities of lubricant at periodic intervals.
2. Non-lubricating foreign matter is excluded.
3. Economy of lubricants.
4. Minimum hazard in handling or filling.
5. Remote control.

These principles relate particularly to heavy duty machinery bearings. The advantages of pressure lubrication are obvious. Study of means for centralized lubrication of such bearings, therefore, was a logical consequence.

The lubricant can be controlled and impelled to the various points of delivery in several ways. In all, however, power in some form or other must be used. Where positive piston displacement types of metering valves are employed at each point to be lubricated, hydraulic power has been found to be especially adaptable as a means of valve control. On such a system either one or two lubricant supply lines can be connected to each valve according to the nature of the service. Here one line serves to load the respective valves periodically with the right amount of grease, the other serving as a discharge medium.

There are other types of centralized pressure systems which require electric power or compressed air for their operation. Some of them are designed to eliminate the necessity for springs, check valves, or restricted port openings. The constant pressure which is exerted upon the lubricant assures of positive flow and the elimination of air pockets. The latter are always objectionable, and their development will depend to some extent upon the body of the lubricant, for the heavier the lubricant the greater the chance that air pockets will develop.

Heavy bodied oils are very often preferred in such systems for the lubrication of hammers and other forging machinery because the oil provides a flushing action on the large slides that are exposed with each stroke of the ram. Some greases, on the other hand, would tend to pick up scale, dirt, and other foreign matter to form an abrasive compound. Oil washes this foreign material away before it can do any harm.

Assessory Bearings

Pressure gun grease lubrication prevails on most of the other important bearings on the drop hammer; and on the forging press unless a centralized pressure lubricating system is installed. On the drop hammer of the steam, air or pneumatic type, the parts which are usually unit-lubricated include the frame bearings on the anvil, and the roll shaft eccentric and floating head bearings; the joints of the valve gear and in some cases the guides or slides.

On the forging press, such parts as the bearings of the clutch and pinion shaft can be lubricated satisfactorily by pressure grease gun.

CONCLUSION

It is hoped that our comments concerning Lubrication in Forging Operations will indicate that lubrication should be regarded as a most important associate of machinery maintenance in the forge shop. Space did not permit us to describe in detail all the features of the various machines. Realizing this, the illustrations have been chosen especially for their value in denoting the extent of the investment involved and, wherever possible, the provisions the builders have made to protect this investment by lubrication.

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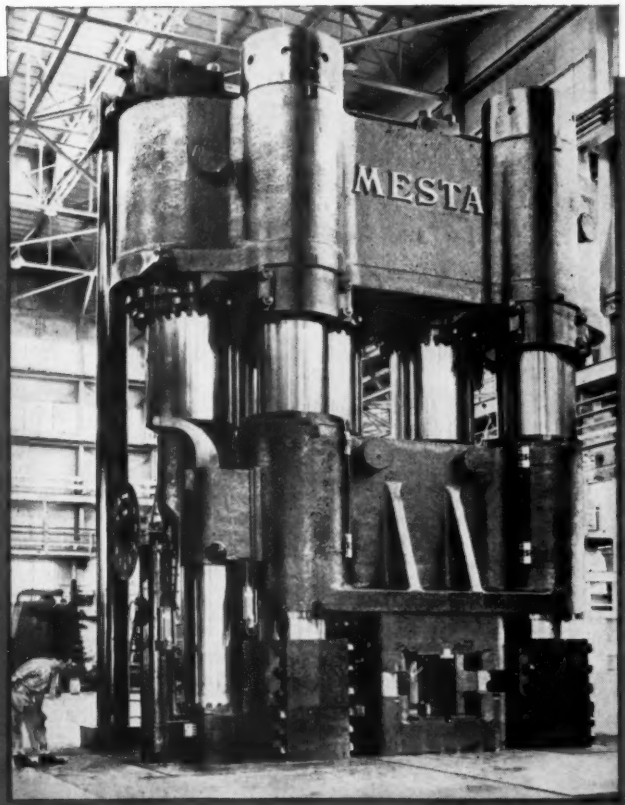

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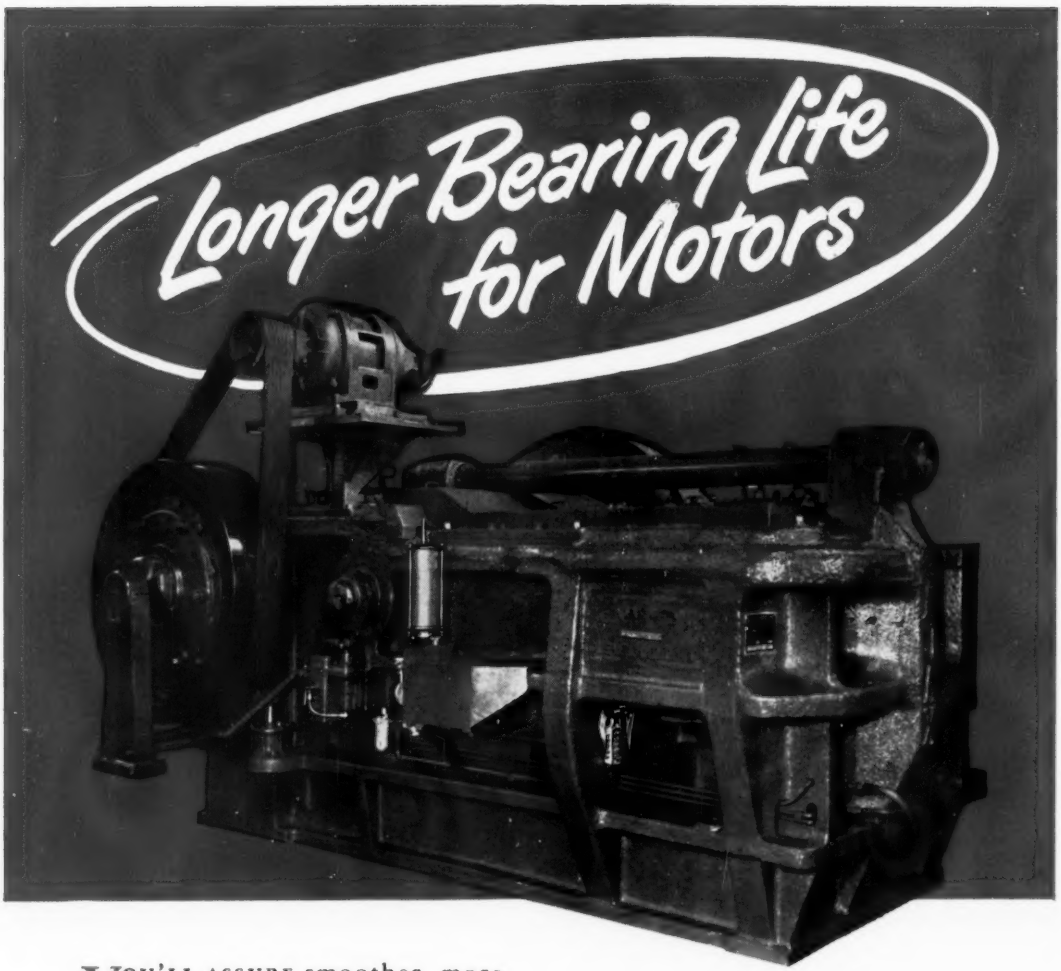

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